

Background/Objective

Engineering vegetative tissues for lipid production is a vital strategy for biofuels, yet achieving high yields remains a significant challenge. This study explores enhancing fatty acid synthesis by redirecting cytosolic phosphoenolpyruvate (PEP) into plastids via *AtPPT1* translocator overexpression. The objective was to determine how cytosolic carbon availability dictates the metabolic outcome and success of this enhanced plastidic PEP transport strategy.

Approach

- Overexpressed *AtPPT1* in both wild-type and sugar-hyperaccumulating (*sweet11;12;13*) backgrounds of *Arabidopsis thaliana*.
- Used metabolomic and transcriptomic analyses to track carbon flux coordination and changes in metabolite levels.
- Characterized lines using confocal microscopy, RT-qPCR, GC-FID for total fatty acid (TFA) quantification and Nile red for visualization of lipid droplets.

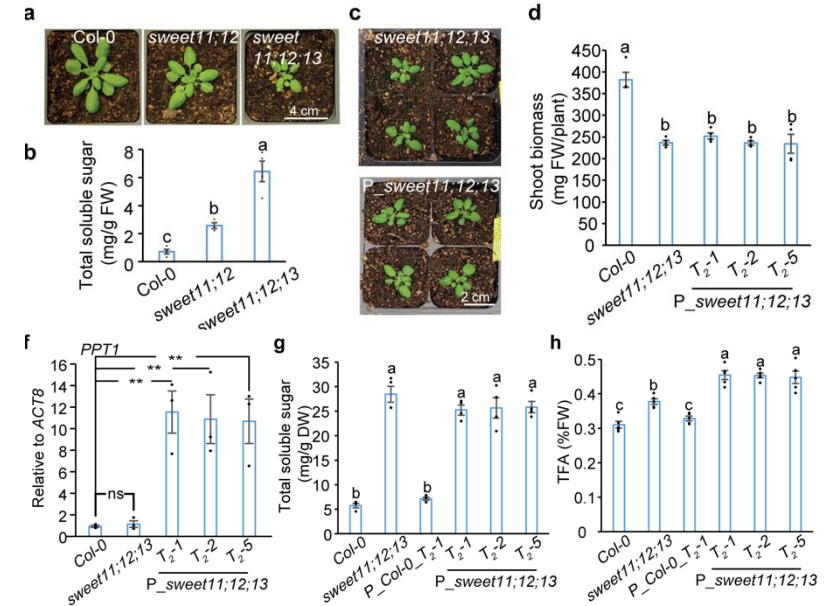
Results

- PPT1* overexpression in wild-type plants did not increase TFA, indicating substrate limits under normal conditions.
- In sugar-rich mutants, *PPT1* significantly increased TFA (up to 46.5%) and boosted lipid droplet accumulation.
- Overexpression alleviated metabolite congestion and increased PFK activity, linking PEP import to higher glycolytic throughput.

Significance/Impacts

This study establishes plastidic PEP redirection as an effective strategy to boost lipid production in sugar-rich tissues, offering a vital module for bioenergy crop engineering. By showing that success depends on a specific metabolic context, requiring high cytosolic carbon, these findings provide a roadmap for increasing oil yields in high-sugar accumulating tissues, such as sugarcane stem and sweet sorghum stem. Ultimately, this approach could enhance biofuel production by maximizing TFA and lipid accumulation in non-seed tissues.

Wang et al. 2026. "PPT1-mediated Plastidic Phosphoenolpyruvate Import Enhances Fatty Acid Biosynthesis in Sugar-rich Tissues." *New Phytologist*. DOI: 10.1111/nph.71160.



Overexpressing phosphoenolpyruvate/phosphate translocator (PPT1) increased total fatty acid (TFA) content in sugar-rich Arabidopsis mutant leaves.